Implementing Detailed Efficiency Data for Optimal Use in Hydroelectric Generating Plants

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Hydro-Quebec

Detailed efficiency data

Individual characteristics of hydroelectric generating unit

Individual efficiency test : 1 test per unit, specific efficiency curve for each unit

vs

Typical efficiency test : 1 test per design, assuming equal efficiency curve for each unit

Investment

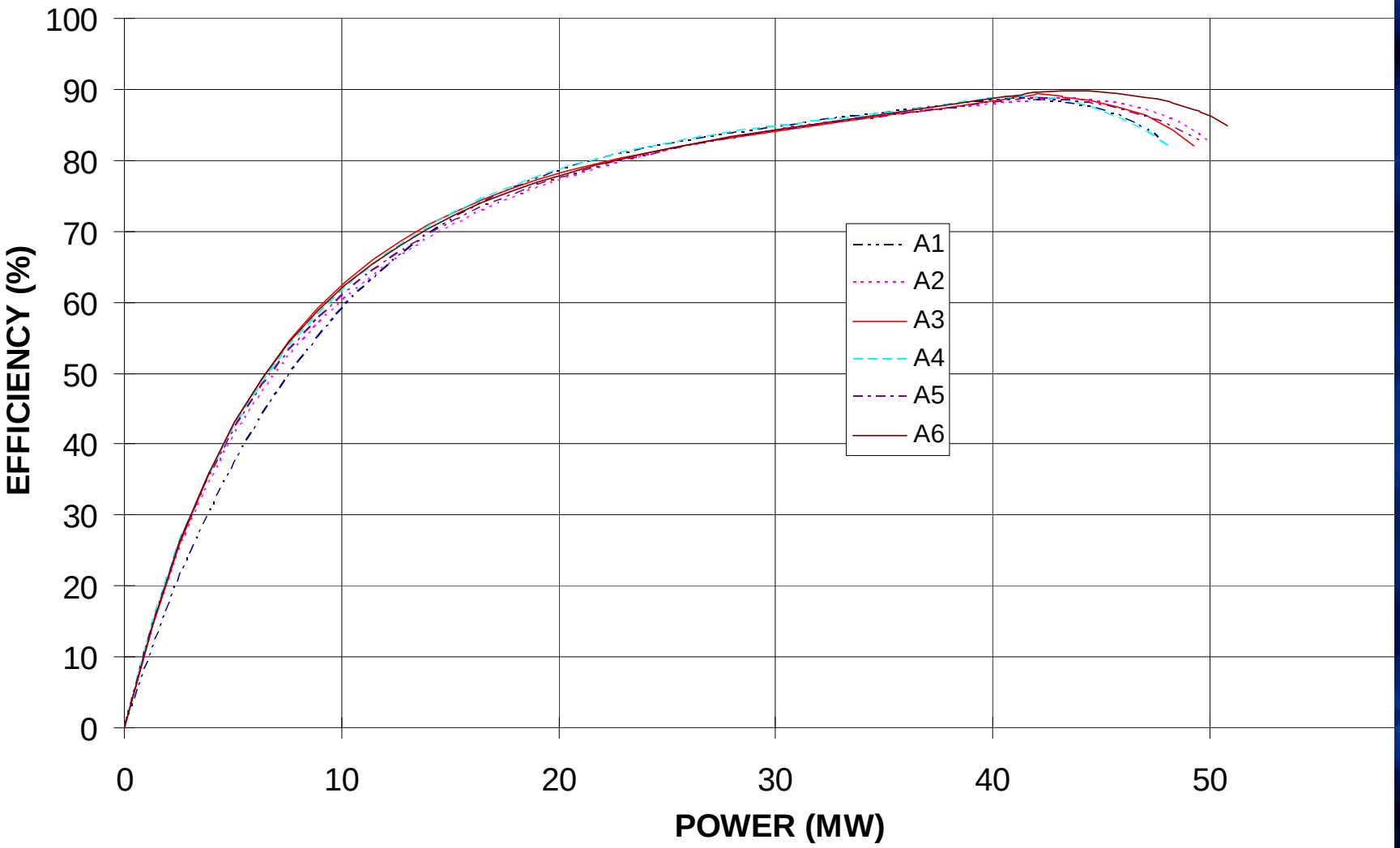
Efficiency test cost : approx. $50,000 / unit

Pay back

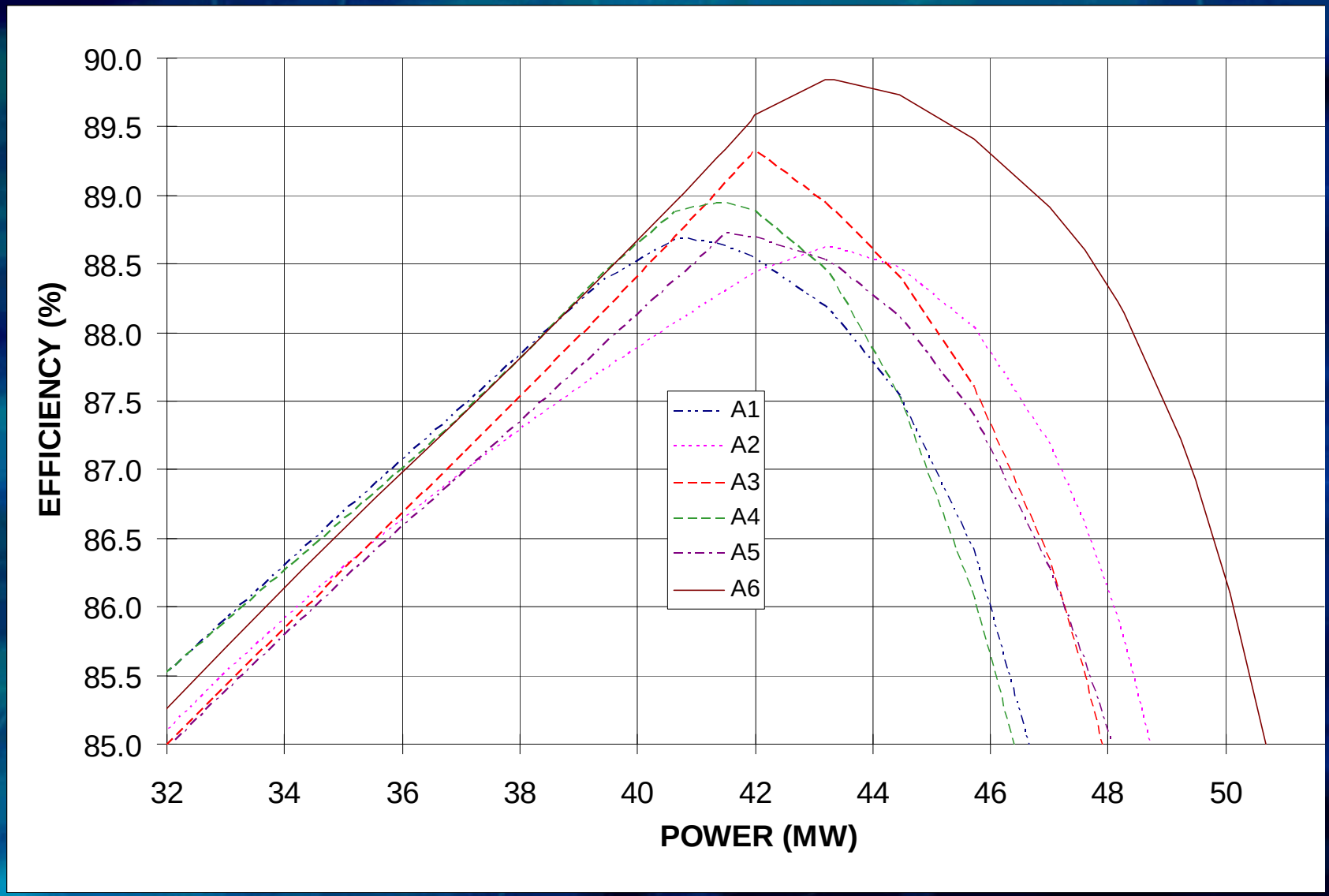
- Better knowledge of each unit : -> information
- Better use of each unit : -> $$

Profitable ?

Individual characteristic at Trenche powerhouse



Individual characteristic at Trenche : zoom



Information -> action:

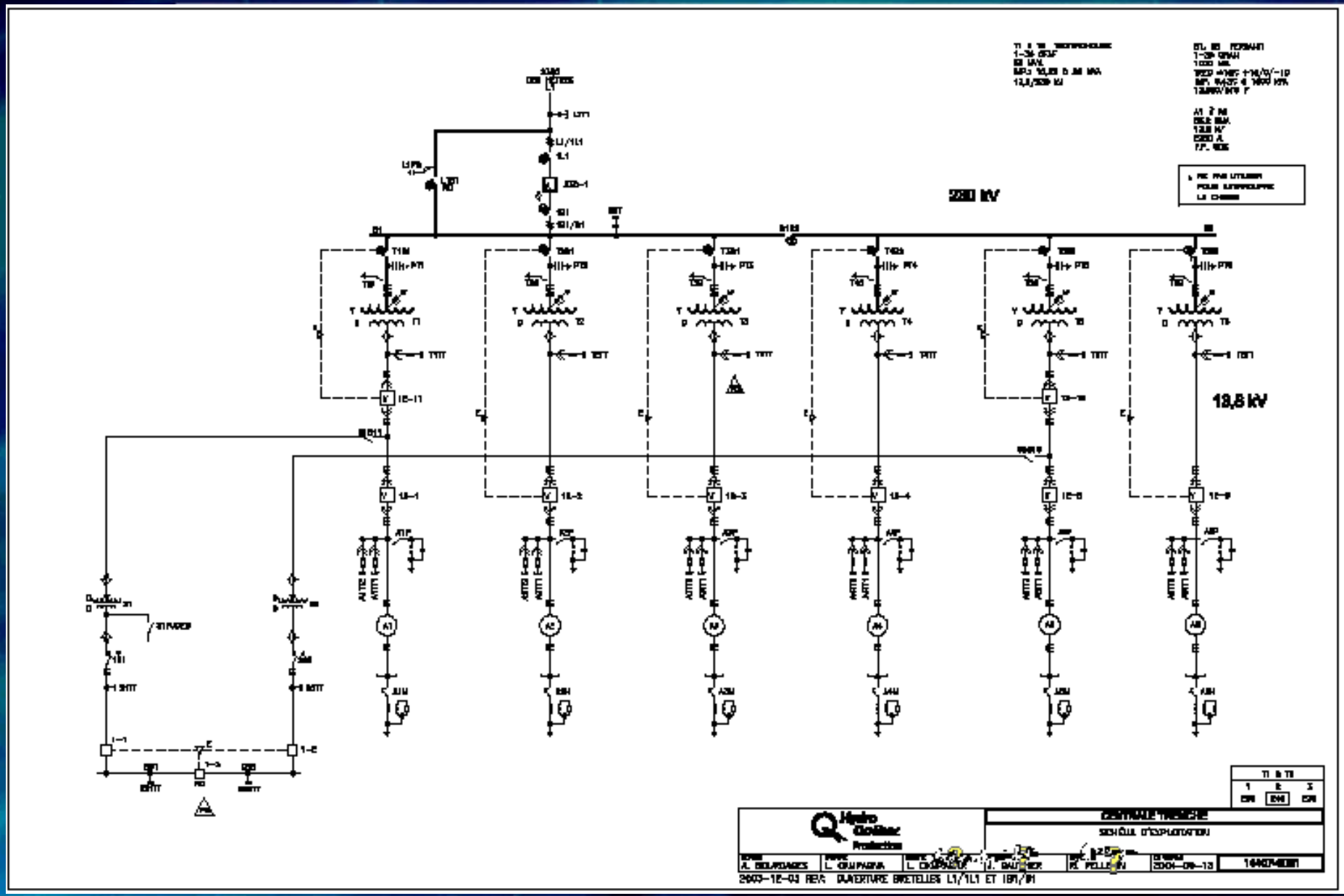
Actions to be taken :

Question ?	Answer
1 Which unit	Priority list
2 How many units	Switching point table
3 How many MW per unit	Optimal MW sharing by Automatic splitter (or guide for operator)

Ideal priority list

Trenche priority list according to maximum efficiency only			
Priority	unit #	efficiency (%)	Supply
1	6	89.85	
2	3	89.33	
3	4	88.94	
4	5	88.72	SA1
5	1	88.68	SA2
6	2	88.62	

Trenche single line diagram



Practical priority list

Considering

- Maximum efficiency
- Operational constraints: feeding powerhouse load, feeding specific local load …
- Reach a compromise with powerhouse operator

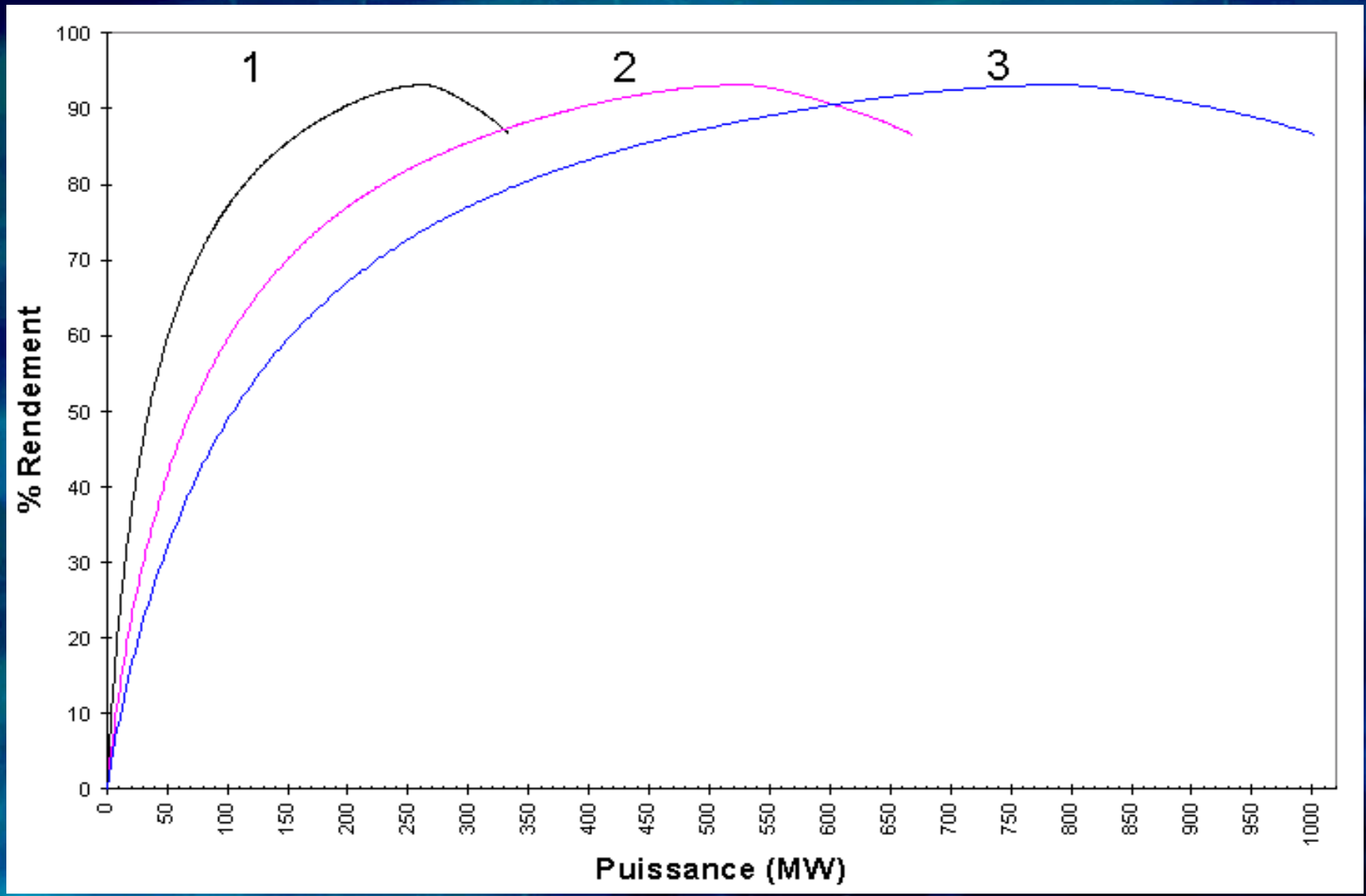
Practical priority list

Trenche priority list according to maximum efficiency and others constrains			
Priority	unit #	efficiency (%)	Supply
1	1	88.68	SA2
2	6	89.85	
3	3	89.33	
4	4	88.94	
5	5	88.72	SA1
6	2	88.62	

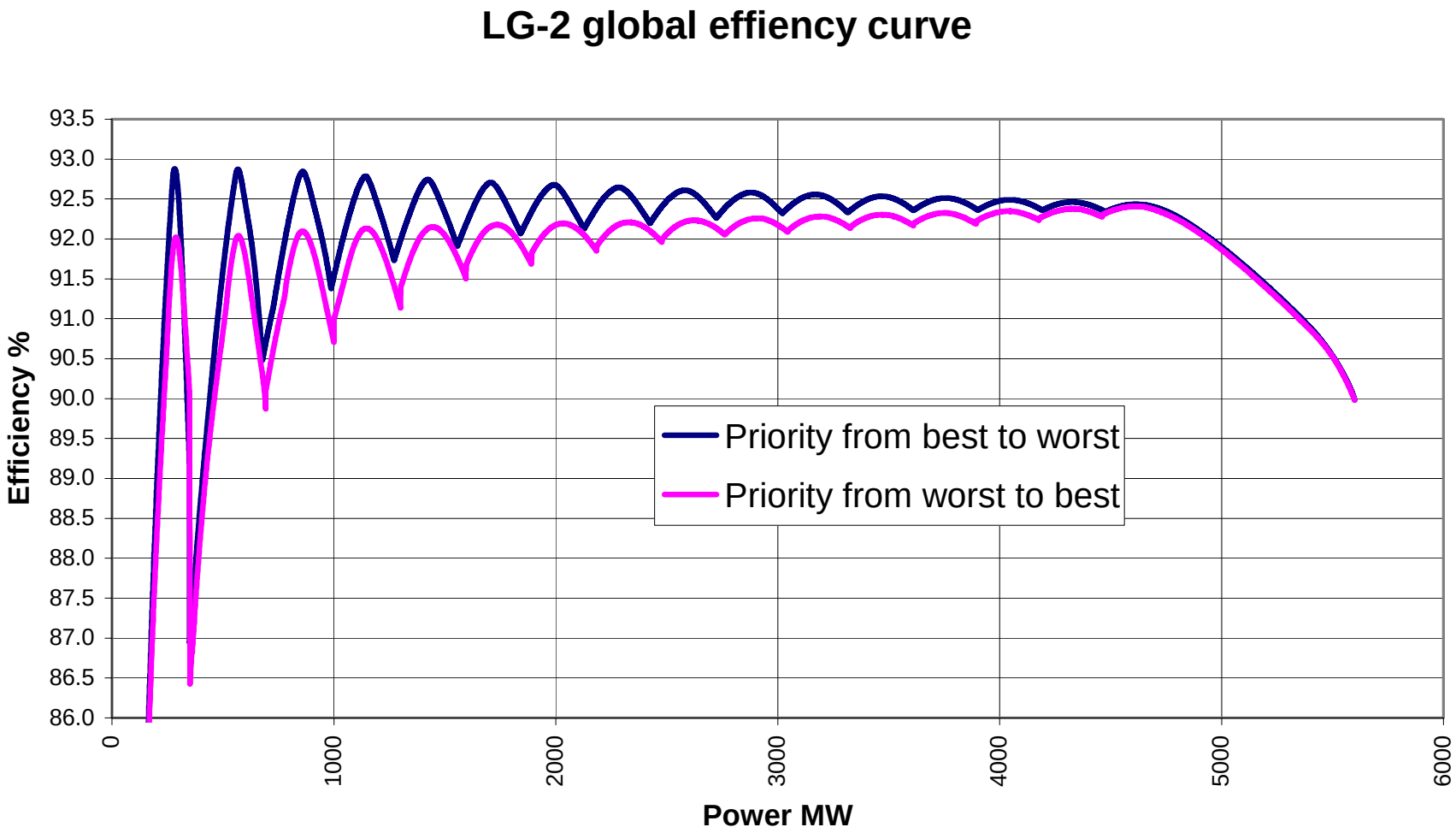
Priority rules to prepare Practical priority list taking into account availability

Priority	Choice rules
1	Choose a unit to supply powerhouse load (favor unit # 6)
2 and up	Choose any unit by order of decreasing efficiency

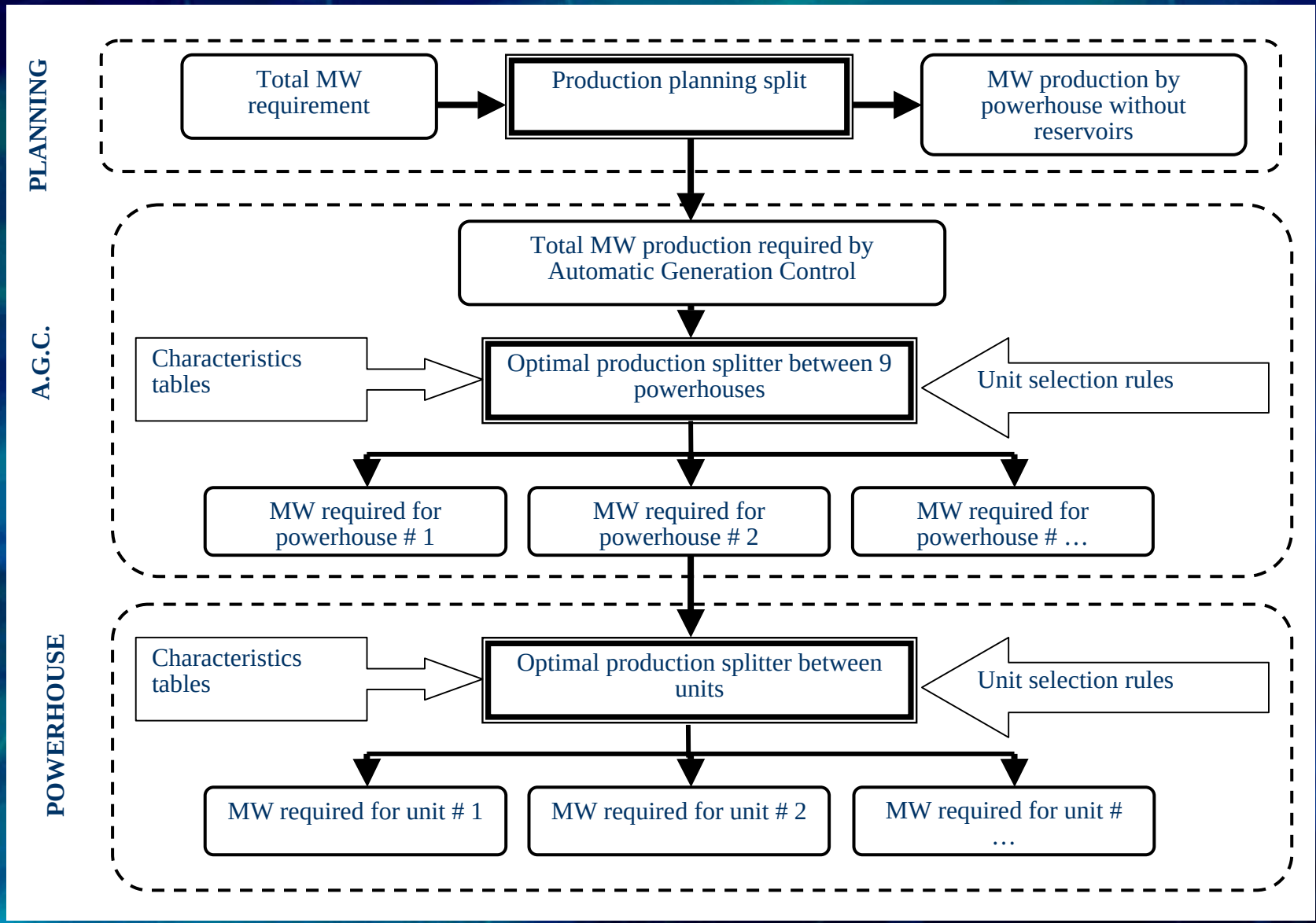
Number of unit to be used for specific power range between switching points



Choice impacts



Production allocation



Summary

To get benefits from individual efficiency measurements

Preparation activities

- 1 Individual efficiency test
- 2 Efficiency curve modelling
- 3 Identify operational constraints

Implementation activities

- 1 Characteristics for Automatic Powerhouse Splitter
- 2 Operator splitting guide for powerhouse without APS
- 3 Operator priority guide for unit selection
- 4 Characteristics for Automatic Generation Control
- 5 Operator priority guide for unit engagement

Individual testing program progress

POWER HOUSE		POWER	A.G.C.	ANNUAL PRODUCTION	PROFIT	
NAME	# UNIT	(MW)		(GWh)	(GWh)	%
Robert Bourassa	16	5616	YES	26534	100	0.377
La Grande 2A	6	2106	NO	9925	8.7	0.088
La Grande 3	12	2418	YES	12428	10.83	0.087
La Grande 4	9	2779	YES	13295	2.17	0.016
Outardes 2	3	472	NO	2506	3.14	0.125
Manic 2	8	1024	YES	5626	6.33	0.113
Manic 5 PA	4	1064	NO	1529	4.41	0.288
La Forge 2	2	319	NO	1685	0.75	0.045
Trenche	6	302	NO	1589	10.2	0.642
TOTAL: 9	66	16100		75117	146.53	0.195
TOTAL HQ: 51	335	33474		189643		

Profitable ?

- Testing: 66 units X $50,000 = $3.3 millions
- Payback : 146 GWh X $ 35,000 = $5.1 millions / year

- Note that production gains are estimated and not measurable directly.
- Best case: LG-2: 16 units x $50,000 = $800,000; 100GWh x $35,000 = $3,5000,000 -> payback 3 months.
- Worst case: LG-4: 9 units x $50,000 = $450,000; 2.2 GWh x $35,000 = $77,000 -> payback 6 years.

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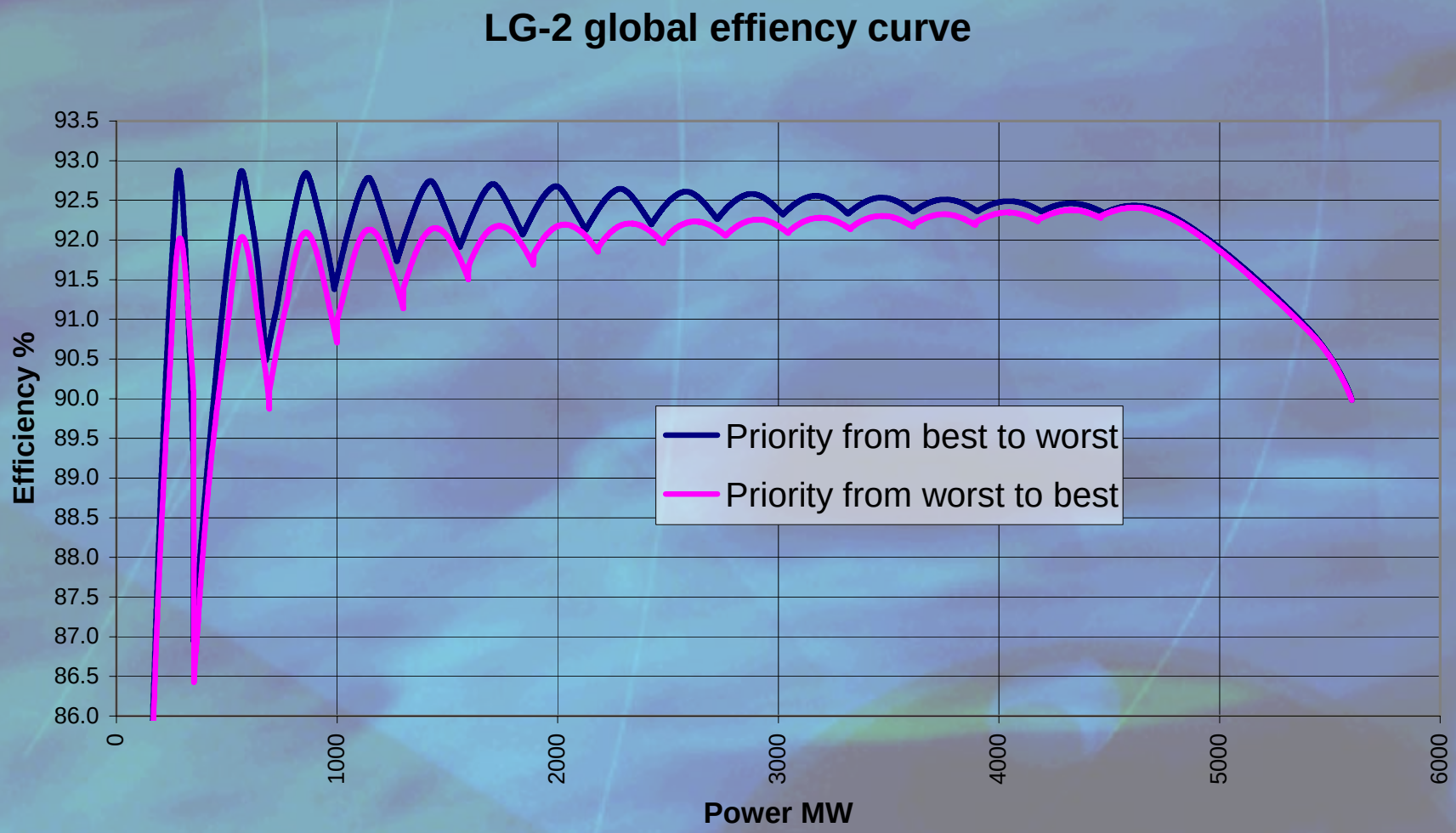
scheduled for 2005 :

Individual efficiency test in 4 powerhouses

Profits increase if :

- Units are big (La Grande, Manicouagan)
- Units are quite different (older units, cavitations repairs …)
- Powerhouse has many units
- Few units are in use (link to Operating Factor)
- Optimal production splitter is used
- Best units are compatible with operational constraints
- This is the case at LG-2 where 2/3 of Hydro-Québec gain was made

Best case : LG-2



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Comments !
Questions ?

Typical powerhouse